

WHAT IS CLAIMED IS:

- 1 1. An implantable medical device comprising:
2 a wireless receiver configured to communicate wirelessly with an external
3 transmitter of an external device via a plurality of communication channels each having a
4 different frequency within a frequency band, the wireless receiver comprising a wideband
5 receiver circuit configured to detect a signal from any of the plurality of communication
6 channels at the different frequencies within the frequency band simultaneously.
- 1 2. The device of claim 1 wherein the frequency band is between 402 and
2 405 MHz, and wherein the plurality of communication channels comprise n contiguous
3 channels of $(3 \div n)$ MHz each in the frequency band.
- 1 3. The device of claim 1 wherein the wideband receiver circuit comprises
2 a front end filter configured to filter a signal received from the external transmitter, a low
3 noise amplifier coupled to the front end filter to amplify the filtered signal, a local oscillator
4 producing an output, and a mixer coupled to the low noise amplifier and the local oscillator to
5 multiply the output of the local oscillator with the amplified received signal from the low
6 noise amplifier and generate a mixer output signal.
- 1 4. The device of claim 3 wherein the wideband receiver circuit comprises
2 a bandpass filter coupled to the mixer which filters the mixer output signal, an intermediate
3 frequency amplifier coupled to the bandpass filter to be driven by an output of the bandpass
4 filter, and a demodulator coupled to the intermediate frequency amplifier to demodulate an
5 intermediate frequency signal from the intermediate frequency amplifier to a baseband signal,
6 and a decoder unit to decode the baseband signal.
- 1 5. The device of claim 4 wherein the bandpass filter is a third-order filter
2 having a center frequency of about 10.7 MHz, a passband width of about 4 MHz, and a
3 passband ripple of about 0.1 dB.
- 1 6. The device of claim 3 wherein the wideband receiver circuit comprises
2 a demodulator circuit coupled to the intermediate frequency amplifier which drives a cell in
3 the demodulator circuit to produce a demodulator output.
- 1 7. An implantable medical device comprising:

2 a wireless receiver configured to communicate wirelessly with an external
3 transmitter of an external device via a plurality of communication channels each having a
4 different frequency within a frequency band, the wireless receiver comprising a receiver
5 circuit configured to detect a signal from any of the plurality of communication channels at
6 the different frequencies within the frequency band;

7 wherein the wireless receiver is configured to detect wirelessly a signal from
8 the external transmitter at a primary predetermined time arranged in a previous
9 communication with the external transmitter.

1 8. The device of claim 7 wherein the wireless receiver is configured to
2 detect wirelessly a signal from the external transmitter at a secondary predetermined time
3 arranged in the previous communication with the external device if the wireless receiver fails
4 to detect wirelessly a suitable signal from the external transmitter at the primary
5 predetermined time.

1 9. The device of claim 7 wherein the wireless receiver is configured to
2 scan for signals from the external transmitter at preset time periods if the receiver fails to
3 detect wirelessly a suitable signal from the external transmitter at the primary predetermined
4 time.

1 10. An implantable medical device comprising:

2 a wireless receiver configured to communicate wirelessly with an external
3 transmitter of an external device via a plurality of communication channels each having a
4 different frequency within a frequency band, the wireless receiver comprising a receiver
5 circuit configured to detect a signal from any of the plurality of communication channels at
6 the different frequencies within the frequency band; and

7 a wireless transmitter configured to communicate wirelessly with an external
8 receiver of the external device via the plurality of communication channels, wherein the
9 wireless transmitter is configured to transmit a signal to the external receiver via a
10 communication channel which is used by the external transmitter to communicate with the
11 wireless receiver of the implantable medical device as detected by the receiver circuit.

1 11. A method for communicating between an external device having an
2 external transmitter and an implantable medical device having a wireless receiver, the method
3 comprising:

4 providing a wideband receiver circuit in the wireless receiver of the
5 implantable medical device configured to communicate wirelessly with the external
6 transmitter via a plurality of communication channels each having a different frequency
7 within a frequency band; and

8 detecting with the wideband receiver circuit a signal from any of the plurality
9 of communication channels at the different frequencies within the frequency band
10 simultaneously.

1 12. The method of claim 11 wherein detecting with the wideband receiver
2 circuit comprises:

3 filtering a signal with a filter according to the frequency band;

4 amplifying the filtered signal;

5 mixing the amplified filtered signal with a local oscillator signal to generate a
6 mixer output signal having a high frequency components equal to a sum of the frequencies of
7 the amplified filtered signal and the local oscillator signal and an intermediate frequency
8 component equal to difference of the frequencies of the amplified filtered signal and the local
9 oscillator signal; and

10 filtering out the high frequency component to provide an intermediate
11 frequency signal having the intermediate frequency component.

1 13. The method of claim 12 wherein filtering out the high frequency
2 component comprises passing the mixer output signal through a bandpass filter.

1 14. The method of claim 13 wherein the bandpass filter is a third-order
2 filter having a center frequency of about 10.7 MHz, a passband width of about 4 MHz, and a
3 passband ripple of about 0.1 dB.

1 15. The method of claim 12 wherein detecting with the wideband receiver
2 circuit further comprises:

3 amplifying the intermediate frequency signal;

4 demodulating the intermediate frequency signal to a baseband signal; and

5 decoding the baseband signal.

1 16. A method for communicating between an external device having an
2 external transmitter and an implantable medical device having a wireless receiver, the method
3 comprising:

4 providing a receiver circuit in the wireless receiver of the implantable medical
5 device configured to communicate wirelessly with the external transmitter via a plurality of
6 communication channels each having a different frequency within a frequency band; and
7 detecting with the receiver circuit a signal from any of the plurality of
8 communication channels at the different frequencies within the frequency band;
9 wherein detecting with the receiver circuit comprises detecting wirelessly a
10 signal from the external transmitter at a primary predetermined time arranged in a previous
11 communication with the external transmitter.

1 17. The method of claim 16 wherein detecting with the wideband receiver
2 circuit comprises detecting wirelessly a signal from the external transmitter at a secondary
3 predetermined time arranged in the previous communication with the external device if the
4 wireless receiver fails to detect wirelessly a suitable signal from the external transmitter at the
5 primary predetermined time.

1 18. The method of claim 16 wherein detecting with the wideband receiver
2 circuit comprises scanning for signals from the external transmitter at preset time periods if
3 the receiver fails to detect wirelessly a suitable signal from the external transmitter at the
4 primary predetermined time.

1 19. A method for communicating between an external device having an
2 external transmitter and an implantable medical device having a wireless receiver, the method
3 comprising:

4 providing a receiver circuit in the wireless receiver of the implantable medical
5 device configured to communicate wirelessly with the external transmitter via a plurality of
6 communication channels each having a different frequency within a frequency band;

7 detecting with the receiver circuit a signal from any of the plurality of
8 communication channels at the different frequencies within the frequency band;

9 identifying a communication channel from which the signal is received by the
10 wireless receiver from the external transmitter; and

11 transmitting a signal from a wireless transmitter of the implantable medical
12 device to an external receiver of the external device via the identified communication
13 channel.

1 20. A medical communication system comprising:

an implantable medical device including a wireless receiver and a wireless transmitter; and
an external device including an external transmitter and an external receiver configured to communicate wirelessly with the implantable medical device via a plurality of communication channels each having a different frequency within a frequency band;
wherein the external device is configured to communicate wirelessly with the implantable medical device via a preset communication channel, and wherein the external device is configured to communicate wirelessly with the implantable medical device via an alternate communication channel selected according to an order of priority if the wireless receiver does not detect a suitable signal from the external transmitter using the preset communication channel.

21. The medical communication system of claim 20 wherein the external device is configured to communicate wirelessly with the implantable medical device in a present communication session on a last communication channel used in a last communication session immediately preceding the present communication session.

22. The medical communication system of claim 21 wherein the external device is configured to communicate wirelessly with the implantable medical device in the present communication session on the last communication channel immediately preceding the present communication session as long as the last communication channel provides a suitable signal which is below a monitoring threshold power level regardless of whether the last communication channel has a lower interference than the other communication channels.

23. The medical communication system of claim 21 wherein the external device is configured to communicate wirelessly with the implantable medical device in the present communication session on a second-to-last communication channel used in a second-to-last communication session immediately preceding the last communication session, if the wireless receiver does not detect a suitable signal from the external transmitter using the last communication channel.

24. The medical communication system of claim 20 wherein the order of priority of communication channels selected is based on communication channels used in previous communication sessions in reverse chronological order.

1 25. The medical communication system of claim 20 wherein the
2 implantable medical device is configured to communicate with the external device at a
3 primary predetermined time arranged in a previous communication with the external device.

1 26. The medical communication system of claim 25 wherein the
2 implantable medical device is configured to communicate with the external device at a
3 secondary predetermined time arranged in the previous communication with the external
4 device if the wireless receiver fails to detect wirelessly a suitable signal from the external
5 transmitter at the primary predetermined time.

1 27. The medical communication system of claim 25 wherein the wireless
2 receiver is configured to scan for signals from the external transmitter at preset time periods
3 if the wireless receiver fails to detect wirelessly a suitable signal from the external transmitter
4 at the primary predetermined time.

1 28. A method for communication between an implantable medical device
2 having a wireless receiver and a wireless transmitter and an external device having an
3 external transmitter and an external receiver, the implantable medical device and the external
4 device being configured to communicate wirelessly with one another via a plurality of
5 communication channels each having a different frequency within a frequency band, the
6 method comprising:

7 attempting initiation of a present communication session between the
8 implantable medical device and the external device using a preset communication channel
9 selected from the plurality of communication channels; and

10 switching to an alternate communication channel for the present
11 communication session according to an order of priority if the wireless receiver of the
12 implantable medical device does not detect a suitable signal from the external transmitter of
13 the external device using the preset communication channel.

1 29. The method of claim 28 wherein attempting initiation of the present
2 communication session comprises selecting as the preset communication channel a last
3 communication channel used in a last communication session immediately preceding the
4 present communication session.

1 30. The method of claim 29 wherein switching to the alternate
2 communication channel comprises selecting as the alternate communication channel a
3 second-to-last communication channel used in a second-to-last communication session
4 immediately preceding the last communication session.

1 31. The method of claim 28 wherein the order of priority of
2 communication channels selected is based on communication channels used in previous
3 communication sessions in reverse chronological order.

1 32. The method of claim 28 wherein the present communication session is
2 initiated at a primary predetermined time arranged in a previous communication with the
3 external device.

1 33. The method of claim 32 wherein the present communication session is
2 initiated at a secondary predetermined time arranged in the previous communication with the
3 external device if the wireless receiver fails to detect wirelessly a suitable signal from the
4 external transmitter at the primary predetermined time.

1 34. The method of claim 32 wherein initiating the present communication
2 session comprises scanning with the wireless receiver for signals from the external
3 transmitter at preset time periods if the wireless receiver fails to detect wirelessly a suitable
4 signal from the external transmitter at the primary predetermined time.

1 35. The method of claim 28 wherein switching to the alternate
2 communication channel comprises selecting a communication channel having a lowest
3 channel interference as the alternate communication channel based on measurement of
4 channel interference conducted prior to attempting initiation of the present communication
5 session.

1 36. The method of claim 35 wherein the alternate communication is
2 selected based on measurement of channel interference immediately prior to the present
3 communication session.

1 37. The method of claim 35 wherein the alternate communication is
2 selected based on a statistical combination of multiple measurements of channel interference
3 over time prior to the present communication session.

1 38. The method of claim 28 wherein attempting initiation of the present
2 communication session comprises selecting as the preset communication channel a last
3 communication channel used in a last communication session immediately preceding the
4 present communication session as long as the last communication channel provides a suitable
5 signal which is below a monitoring threshold power level regardless of whether the last
6 communication channel has a lower interference than the other communication channels.